# A MODEL FOR ESTIMATING FUTURE INFLUENT AND EFFLUENT HYDRAULIC FLOW TO THE SJ/SC WPCP

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## INTRODUCTION

The ability to predict future wastewater flows has been an ongoing goal of the San Jose/Santa Clara Water Pollution Control Plant (Plant). Flow modeling and flow reduction programs are needed to meet the Plant's hydraulic flow trigger of 120 million gallons per day (mgd) average dry-weather effluent flow (ADWEF)[1]. The Watershed Protection Division of ESD has prepared a predictive model of hydraulic sewer flows entering the Plant (influent) and treated wastewater discharge (effluent). This memorandum documents the methodology, assumptions, and preliminary outcome of the model.

## PURPOSE OF FLOW MODEL

The purpose of the flow model is to provide a tool that estimates Plant dry-weather influent flow (PIF) and Plant effluent flow (PEF). The model may be used in the near term to predict PIF and PEF. In the medium to long-term (i.e., in five-year increments out 25 years), it provides a range of potential future PIF to assist in Plant capacity and effluent reduction planning. It also provides sensitivity analysis based on a slow or robust economy.

## INFLUENT FLOW PROJECTION METHODOLOGY

The steps in developing the model included:

- obtaining ABAG projection reports (1998, 2000, and 2002);
- compiling resident population and jobs in PSA;
- obtaining monthly employment data from CEDD;
- developing per capita influent flow factors per resident and employee by sector;
- developing upper and lower PIF projection growth trends; and
- calibrating flow factors using PSA water use and Plant influent data.

The model estimates PIF using growth in residential population and employment by job sector in the Plant Service Area (PSA). It utilizes demographic data projections developed by the Association of Bay Area Governments (ABAG)[2] including population and job sector projections in 5-year

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[1] The ADWEF is defined in Board Order WQ90-5 as "the lowest average effluent flow for any three consecutive months between the months of May and October".

[2] ABAG is a regional planning agency that collects and analyzes demographic data by County throughout the San Francisco Bay Area. They provide summaries of their analyses and projections for future resident population and employment trends by industry in semiannual reports, utilizing data from the previous two years. ABAG reports from 1998, 2000 and 2002 were analyzed to develop upper and lower ranges for future population and job growth in

increments up to 2025. These values have been calibrated using the actual monthly job figures published by the California Employment Development Department (CEDD). Per capita influent flow factors (in gallons per day) are then applied to the number of people living and working in the PSA to generate total PIF in millions of gallons per day (mgd). Upper and lower PIF trend lines were developed using the highest and lowest demographic projections by ABAG based on a strong economy (i.e., low unemployment of 2%) and a slow economy (i.e., high unemployment of 7%). Alternative flow reduction programs can be incorporated into the model to predict future ADWEF to the Bay and the likelihood and timing of exceeding 120 mgd.

PSA Demographics: Historical and projected estimates for the number of people living and working in the PSA are provided in Figure 1. Residential population, which increased by 150,000 (14%) from 1990 to 2000 to 1,246,900, is expected to increase 154,000 from 2000 to 2010 (12%) and 287,000 by 2025 (23%). The number of jobs in the PSA, which grew by 164,500 (29%) between 1990 and 2000, is expected to grow by 89,000 (12%) from 2000 to 2010 and by 210,000 (29%) by 2025.

**Figure 1: Resident Population and Jobs in PSA: 1990 – 2025**


Source: U.S. Census 2000, CEDD, and ABAG Projections 2002

Job Sectors: Job sectors in the ABAG Projections reports are defined using categories in the 1987 Standard Industrial Classification (SIC) Manual issued by the federal Office of Management and Budget. A summary of these job categories and the number of jobs in each within the PSA are shown in Table 1 for the year 2000.

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the model. The growth rates in the *Projections 1998* report were used to represent the low end (which was preceded by a slower economy and housing growth). The data and growth rates in the *Projections 2002* report were used to represent the high end (preceded by a robust economy and push for new housing construction).

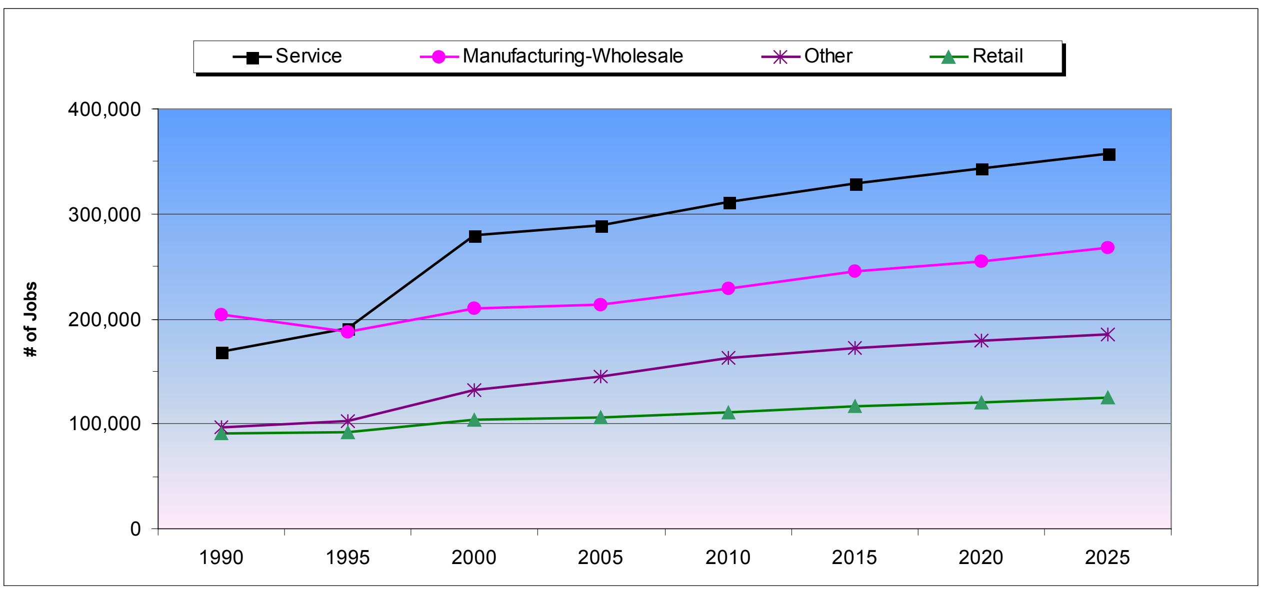
**Table 1: Jobs Summary in Plant Service Area**

| Category | SIC Codes | Job Sectors | Jobs in PSA | |
|---|---|---|---|---|
| Manufacturing and Wholesale | 20-39 | Manufacturing and wholesaling of all durable and non-durable goods | 209,800 | 29% |
| Retail | 52-59 | All retail, including eating and drinking establishments | 103,500 | 14% |
| Service | 70-89 | All personal, business, repair, motion pictures, amusement, recreation, health, education, legal, social, engineering, accounting, research, management, hotels and other lodging places | 279,300 | 39% |
| Other | 15-17, 40-49, 60-67 and 91-97 | Construction, transportation, communications, utilities, finance, insurance, real estate, and government, including national security | 132,600 | 18% |
| TOTAL | | | 725,200 | 100% |

Sources: ABAG Projections 2002 report. Number of jobs is for year 2000.

The projections for employment by sector are provided in Figure 2. The largest increase over the last ten years has been in the Service sector that realized a 65% growth rate. The biggest future increase is anticipated for the Other sector, which is expected to grow by 40% between 2000 and 2025.

**Figure 2: Jobs by Sector in PSA: 1990 – 2025**




Source: ABAG Projections 2002

Per Capita Flow Factors: Per capita flow factors for the residential sector were developed using local water use data and sewage coefficients. A residential per capita flow factor of 60 gallons per day (gpd) was calculated by applying the average household density in the PSA of 3.1 persons per household to the average per household indoor water use of 186 gpd.[3] A summary of this analysis is

[3] The average residential flow factor of 186 gpd per household from the *CSJ Water Use and Conservation Baseline Study, April 1999*.

presented in Table 2, with the single-family dwelling figures representing detached and attached (townhouse and condominium) units, and the multi-family dwellings representing apartments and mobile home units. The resulting residential influent flow in year 2000 is 75 mgd.

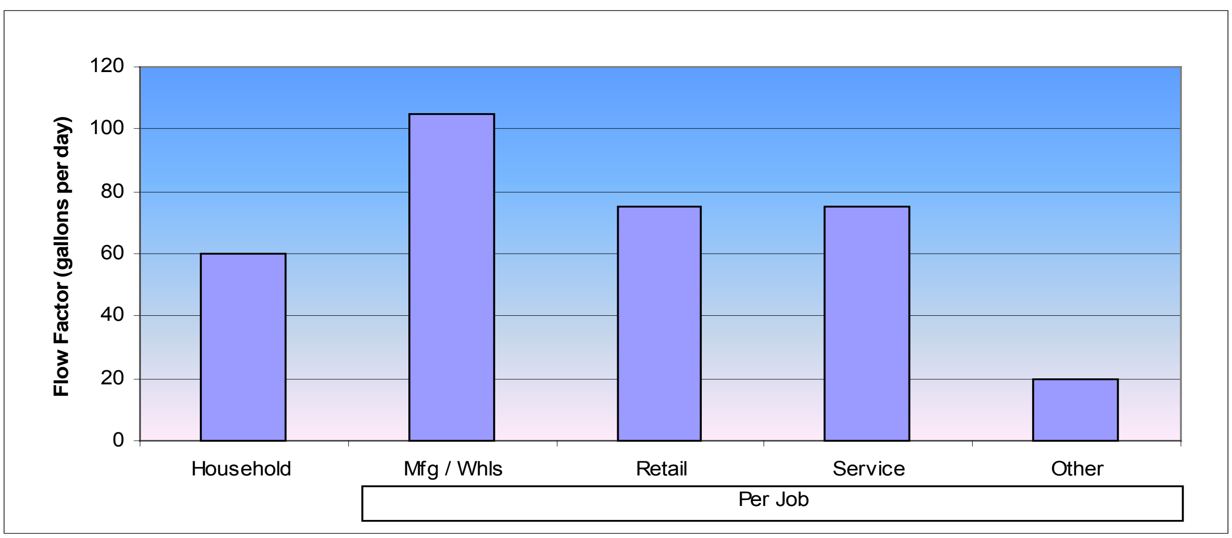
**Table 2: Per Household Residential Flow Factors: Year 2000**

| Dwelling Unit Type | # of Dwelling Units | Gallons per Day/DU | Total Influent (mgd) |
|---|---|---|---|
| Single Family Dwellings | 267,450 | 220 | 58.8 |
| Multi-Family Dwellings | 137,800 | 120 | 16.5 |
| Total *(Avg.)* | 405,250 | **186** | 75.3 |

Sources: Dwelling unit counts represent occupied housing units in PSA as reported by the California Department of Finance. Gallons per day per dwelling unit flow factors from *CSJ Water Use and Conservation Baseline Study*, *April 1999*.

The non-residential flow factors for the four employment sector categories used by ABAG were developed based on industry standards, existing sewage coefficients (flow factors), sewer connection fee applications and flow audits performed in 1999 by large dischargers in the PSA (i.e. >100,000 gpd). The per capita flow factors used in the model are presented in Figure 3. The per capita (job) per day flow factors by sector are 105 gpd for the Manufacturing and Wholesale sector, 75 gpd for the Retail and Service sectors, and 20 gpd for Other. Since there is significant variance in influent production per job within these categories, and the mix of jobs within each category change over time, these flow factors will continue to be revised and calibrated.

**Figure 3: Per Capita Residential and Job Sector Flow Factors**




The flow model is constructed in such a way that it is possible to input resident population and employment figures as they are updated. Per capita flow factors can also be revised to reflect changes in water use behavior and industry practices. This allows for calibration of the model for more accurate projections of flows and estimates of sources of flows. Sensitivity analysis was performed using the changes in population, changes in per capita residential factors (e.g., due to conservation or drought), and historical employment figures in the PSA for prior years.

## INFLUENT FLOW PROJECTIONS

The model develops PIF projections by applying per household and per job flow factors to the number of households and jobs in the PSA. A range of PIF values were developed:

- An upper limit using the projected values for housing and jobs found in the ABAG Projections 2002 Report (representing strong growth in housing development and a robust economy); and
- A lower limit using the flatter growth curves for housing and jobs found in the ABAG Projections 1998 Report (with a corresponding weak housing growth and economy).

It assumes that economic conditions (i.e., number of jobs by sector in the PSA) are a predictive factor of influent flow to the Plant. During periods of economic recession, lower wastewater flows are observed, while a robust economy results in higher wastewater flows. The upper and lower influent flow projections presented in this report represent the expected influent flow envelope in the absence of anomalous water use trends (e.g., during a drought).[4]

Flow Model Trendline Limits: The model projects both an upper and lower limit for PIF beginning in 2002. The years 2000 and 2001 were the two extremes for the local economy, with unemployment rates of 2% and 6% respectively. The upper limit launches from the year 2000 with a PIF of 124.5 mgd, while the lower limit launches from 2001 with a PIF of 119 mgd (see Table 3).[5]

**Table 3: Trendline Upper and Lower Limits Summary**

| Trendline | Launch Year | PIF (actual) | Unemployment Rate | ABAG Projections |
|---|---|---|---|---|
| Upper Limit | 2000 | 124.5 mgd | 2% | 2002 Report |
| Lower Limit | 2001 | 119 mgd | 6% | 1998 Report |

The last three ABAG Projections reports (i.e., 1998, 2000 and 2002) were analyzed to determine the range of housing growth trends for the PSA. The steepest growth rate for housing and jobs was found in the ABAG Projections 2002 report, with the lowest in the ABAG Projections 1998 report. The upper limit projects PIF using the housing growth rate found in ABAG's 2002 report, with an upward adjustment of 2% applied to the five-year increment values to reflect an upper limit for housing growth. The lower limit applies the slower growth rate found in their 1998 report. The

[4] Drought conditions can also have significant impact on water use and PIF. For example, during the drought period 1987 to 1991, potable water use in the PSA dropped 27% while indoor water use and PIF dropped 20%. Although the model may be adjusted to account for changes in water use patterns due to shortages, the PIF projections presented in this report are based on per capita flow factors that are static.

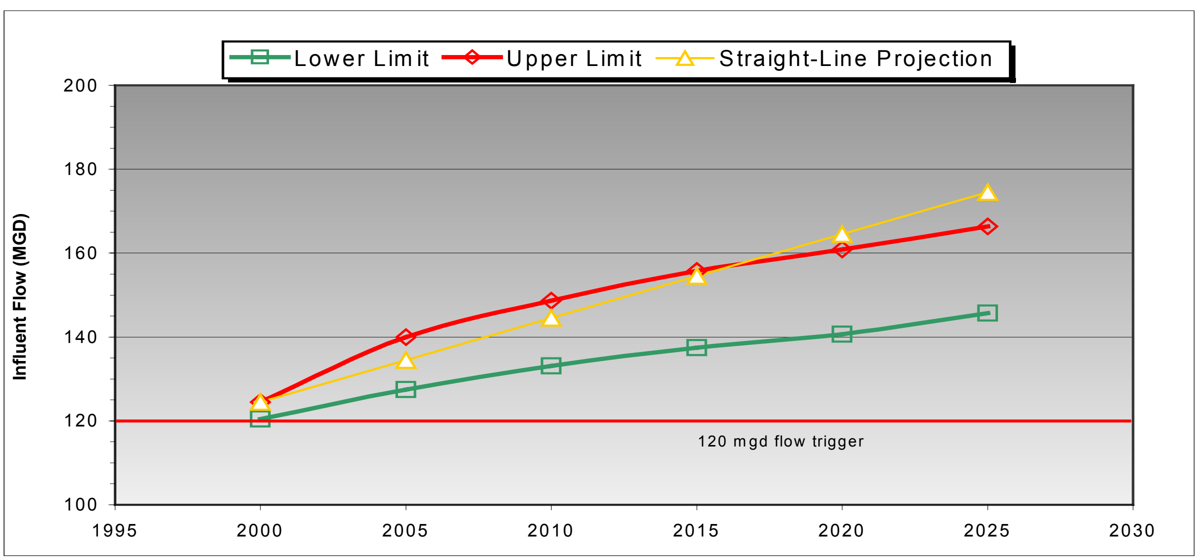
[5] ABAG projections use the historical average for unemployment in Santa Clara County of 5%. To develop the upper limit values, the number of jobs was adjusted "up" to reflect the 2% unemployment rate realized in 2000 (this rate was also the lowest three-month average unemployment rate in the last decade). The lower limit values were adjusted "down" from the historical average to reflect the highest summertime unemployment rate in the last 15 years of 7% (year 1993).

resulting upper and lower limit projections for those living and working in the PSA are presented in Figure 4.

**Figure 4: Upper and Lower Housing and Job Trends**

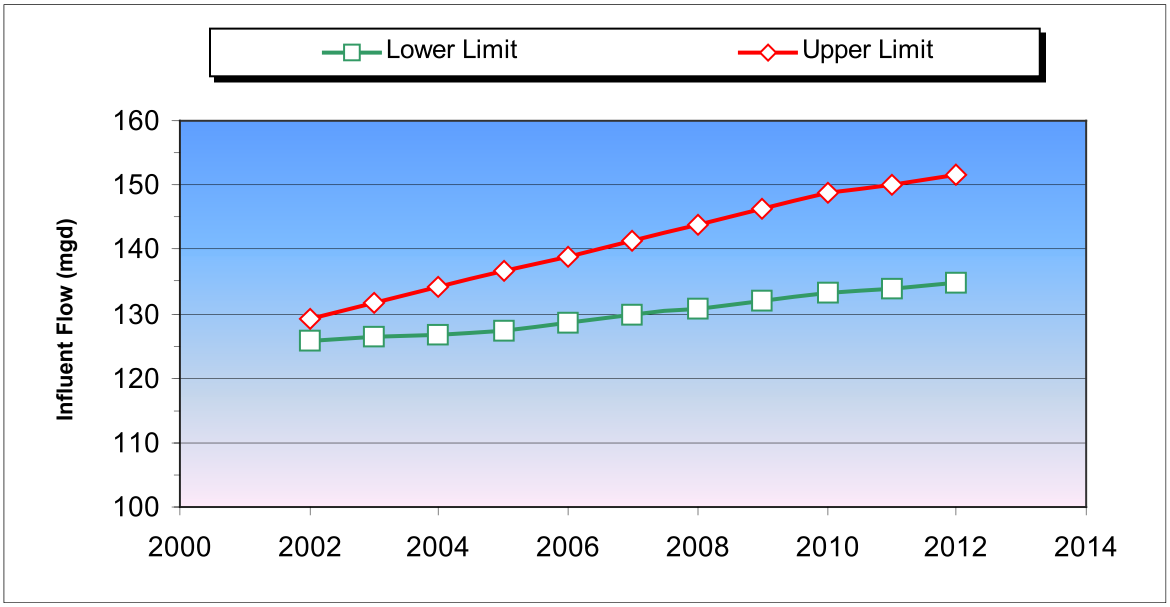

The long-term range of ADWIF predicted by the model is presented in Figure 5. The straight-line growth rate of 2 mgd per year used historically for Plant expansion planning is plotted for comparison.

**Figure 5: Long-Term Influent Flow Projection with No Reduction Programs**




As a basis for projecting near-term effluent flows, a 10-year window (from 2002 to 2012) was used. Figure 6 illustrates the range of theoretical PIF if no influent flow reduction programs (e.g., water conservation) had been implemented since 1999. This projection was used as the basis for evaluating ongoing and future influent and effluent reduction programs over the next 10-years.

### Figure 6: Projected Influent Range with No Reduction Programs



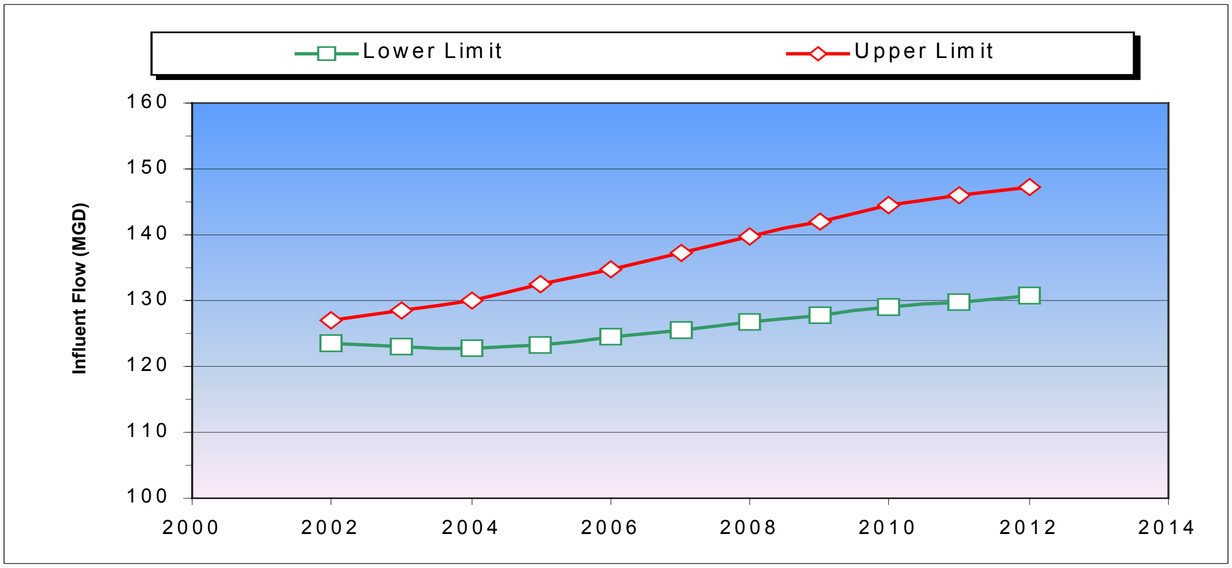

Influent Flow Reductions: The City began implementing its Wastewater Flow Reduction Strategy in 1986. Since that time its water conservation programs have been instrumental in pioneering incentive programs for ultra-low flush toilets (ULFTs), plumbing code and local ordinance development and enforcement. The South Bay Action Plan, initiated in 1992, expanded water conservation programs and established the recycled water program. The Revised South Bay Action Plan (RSBAP) expanded these efforts in 1998 and added groundwater infiltration reduction and industrial water reuse programs to reduce influent flow to the Plant. Funding for these programs has been committed through 2003 and is expected to result in an additional total flow reduction of 3.94 mgd by 2004. Projected influent reduction programs through year 2004 are presented in Table 4.

### Table 4: RSBAP Influent Reduction Programs

| Influent Reduction Programs | Cumulative Flow Reduction (mgd) | | | |
|---|---|---|---|---|
| | 2001 | 2002 | 2003 | 2004 |
| Water Efficiency Program (WEP) | 0.7 | 1.2 | 1.5 | 1.7 |
| Groundwater Infiltration Reduction (GWI) | 0.5 | 1.0 | 1.5 | 2.0 |
| Industrial Recycling | 0.04 | 0.14 | 0.24 | 0.24 |
| **TOTAL** | **1.24** | **2.34** | **3.24** | **3.94** |

The influent reduction programs currently being implemented are accounted for in the flow model and are used to develop the expected influent flow to the Plant. The range of projected PIF with RSBAP influent reduction programs is shown in Figure 7.

**Figure 7: PIF Projection with RSBAP Influent Reduction Programs**




The flow model results presented in this memo use constant flow factors for residential (see Table 2) and non-residential sectors (see Figure 3) from year to year. As actual values are compiled in the future, the model allows for the adjustment of future flow factors from year to year to more accurately reflect changes in demographics and indoor water use trends.[6]

## Near-Term Effluent Flow

Future PEF volumes can be estimated by applying potential flow diversion volumes from various program options. The model predicts Plant ADWEF using the range of values found in Figure 7 to construct the influent flow envelope. Taking these PIF values and subtracting the existing and committed effluent diversion programs generated the PEF projections.

Effluent Flow Reductions: The South Bay Water Recycling (SBWR) Program diverted 10 mgd of effluent from the Plant during summer 2001. Recycled water, meeting California Title 22 water quality requirements, is delivered to more than 350 customers for irrigation and industrial uses. Expansion of the SBWR system is continuing with the implementation of Phase 2A of the program. Additional recycled water markets generated by the projects that have funding commitments are expected to achieve an additional 9.4 mgd of effluent diversions by 2004 (see Table 5 below).

[6] It is likely that after 2004 some level of influent reduction from conservation would occur naturally due to continued enforcement of the plumbing codes and attrition of plumbing fixtures (e.g., replacement of old toilets). However, absent continued programs, conservation behavior may slip and aging fixtures would likely threaten the persistence of past savings (e.g., toilet leaks).

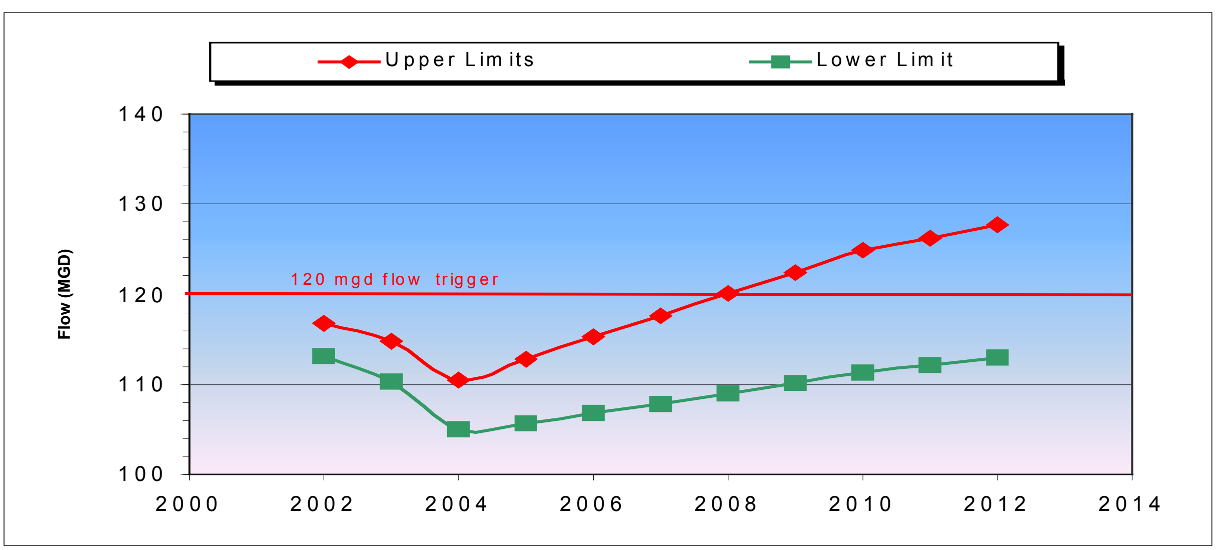
### Table 5: South Bay Water Recycling Program – Phase 2A

| Effluent Reduction Programs- Committed | Cumulative Flow Reduction (mgd)* | | |
|---|---|---|---|
| | 2002 | 2003 | 2004 |
| SC-1 Cemetery/ Golf Course Alignment | | 0.8 | 0.8 |
| M-2 Central Milpitas Alignment | | | 0.4 |
| M-3 McCandless Alignment | | | 0.1 |
| M-4 Town Center Alignment | | 0.4 | 0.4 |
| Los Lagos Municipal Golf Course (Tuers/Capital) | 0.6 | 0.6 | 0.6 |
| Ranches of Silver Creek Golf Course (Cerro Plata) | | 1.1 | 1.1 |
| Santa Clara University | | 0.4 | 0.4 |
| Metcalf Energy Center (MEC)** | | | 3.0 |
| Guadalupe Gardens | | | 0.5 |
| Owens Corning | | 0.03 | 0.03 |
| Smurfit Stone | | 0.1 | 0.2 |
| SVP Pico Plant** | | | 1.0 |
| SC-6 Central Park | | | 0.2 |
| M-5 SJ/Milpitas Connector | | | 0.06 |
| SC-5 SJ/SC Connector – Airport Landscape | | | 0.11 |
| Los Esteros Power Plant** | | 0.5 | 0.5 |
| **TOTAL COMMITTED** | **0.6** | **3.5** | **9.4** |

* In addition to 2001 baseline flows. ** Represents net effluent diversion.

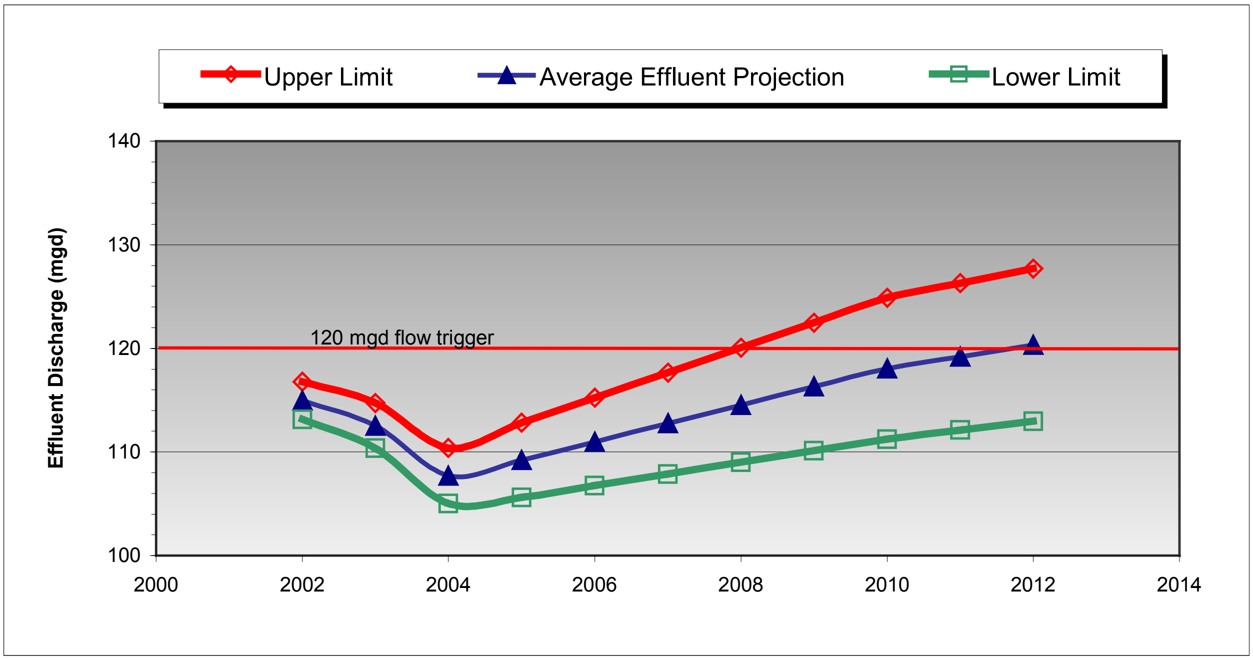
<u>Near-Term Effluent Flow Projection:</u> The near-term ADWEF projections for a slow and robust economy are shown in Figure 8. These projections include estimates for the existing and anticipated flow reduction programs that are planned through 2004. The upper limit projection does not exceed the ADWEF trigger of 120 mgd until after 2008. The lower limit projection resides below 120 mgd until after 2012. In every case, effluent flow from the Plant is expected to increase without additional flow reduction programs. The ADWEF projections in Figure 8 represent the upper and lower boundaries of the effluent flow envelope.

### Figure 8: ADWEF Projections with Committed Influent and Effluent Flow Reduction



The range of ADWEF values projected by the model for the next 10 years is shown in Figure 9. The upper limit values represent potential effluent flows with a robust economy (at a 2% unemployment rate) and aggressive new housing construction. The lower trend line represents a projection with a sluggish economy (7% unemployment) and a slower rate of new housing development. The mid or average trendline represents future PEF using the projection of PIF based on the mid-line values for economic and housing growth in the PSA.

**Figure 9: ADWEF Envelope with Mid-Line Estimate**




Application of the Model: ADWEF are expected to be below the 120 mgd ADWEF trigger through the term of the next NPDES operating permit for the Plant (2003 – 2008) and beyond. However, due to the time required to plan and implement effective reduction programs, planning horizons may be needed to bring additional flow reduction programs on-line in a timely manner. The model can be used to help determine the flow reduction targets for future programs and their implementation schedules. The identification of planning flow thresholds could coincide with the future assessment of flow reduction strategies.

Future Refinements: Actual Plant influent and effluent flows, water use and economic conditions should be analyzed on a periodic basis and incorporated into the model to refine the flow projections. These refinements should also include revised ABAG projections (published every two years) and the residential and non-residential flow factors as demographics and indoor water use trends change over time. Maintenance of the model will allow it to remain a relevant tool for making informed decisions about the future of recycled water and wastewater planning for the City and the region.

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